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Ito et al.

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(54) **DISCHARGE LAMP AND LIGHT SOURCE DEVICE**

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H01J 61/54	(2006.01)
H01J 61/067	(2006.01)
H01J 61/56	(2006.01)
H01J 61/52	(2006.01)

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(58) **Field of Classification Search**
CPC H01J 65/00; H01J 61/10; H01J 61/68; H01J 61/30
USPC .... 315/94, 200 R, 326; 313/634, 637
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2004/0021419	A1 *	2/2004	Ito	H01J 61/10	313/637
2004/0046506	A1 *	3/2004	Kawai	H01J 61/68	313/634

FOREIGN PATENT DOCUMENTS

JP	H02-273452 A	11/1990
JP	H06-060852 A	3/1994

(Continued)

OTHER PUBLICATIONS

English-language translation of International Preliminary Report on Patentability (IPRP) dated Mar. 5, 2015 that issued in WO Patent Application No. PCT/JP2013/069511.

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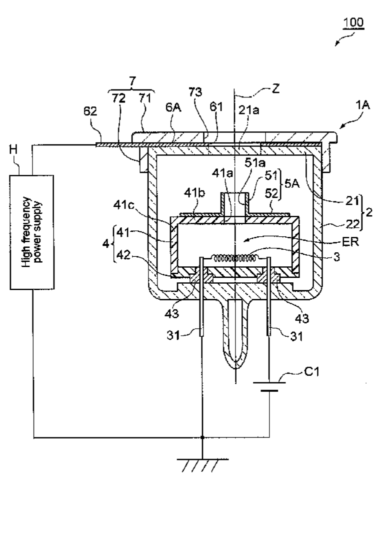
(57) **ABSTRACT**

A discharge lamp includes a housing including a dielectric portion having a light transmission area formed of a dielectric material and transmitting light, and a main body portion forming a discharge-gas-filled space together with the dielectric portion, the discharge-gas-filled space being filled with a discharge gas; an electron emission source disposed in the discharge-gas-filled space to face the light transmission area; a discharge path limiting member separating the electron emission source and the light transmission area, in the discharge-gas-filled space, and including an electron passage hole that transmits electrons emitted from the electron emission source; and an external electrode disposed at an outer side of the housing to face the electron emission source across the dielectric portion, and including an opening that passes the light transmitted through the light transmission area.

10 Claims, 7 Drawing Sheets



(56) **References Cited**

FOREIGN PATENT DOCUMENTS

JP	H09-190803	A	7/1997
JP	3385170	B2	3/2003
JP	2005-519437	A	6/2005
JP	2007-335130	A	12/2007
JP	2008-108635	A	5/2008
WO	WO-02/49072	A1	6/2002

* cited by examiner

Fig.1

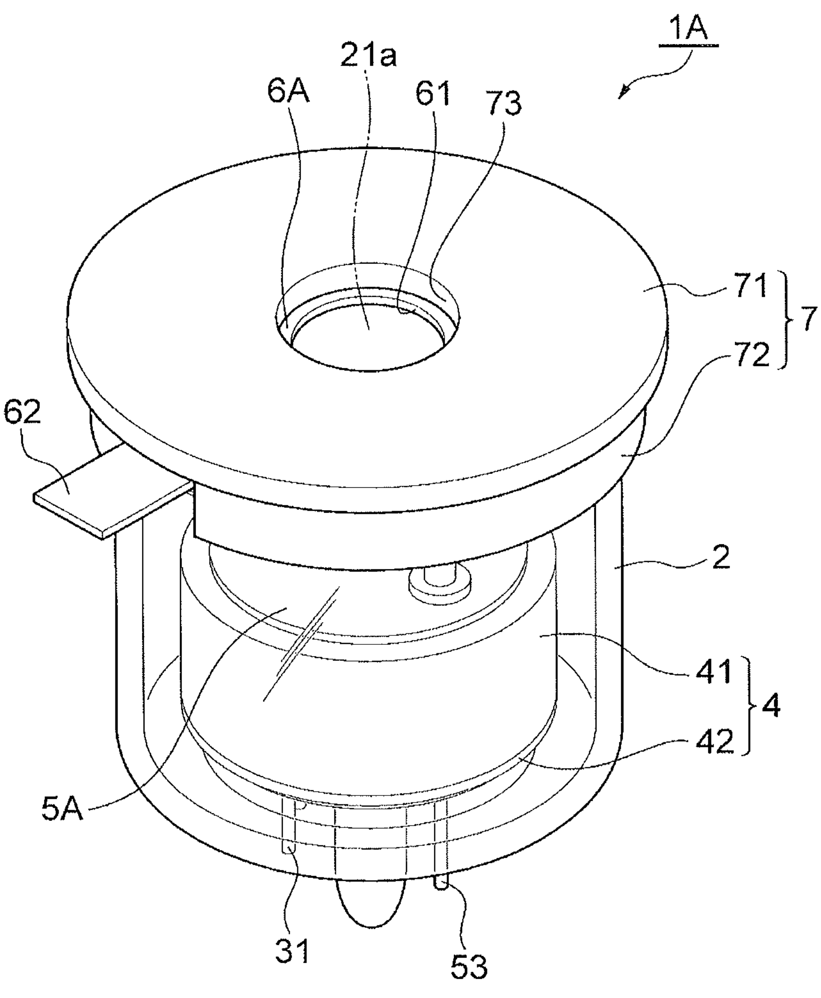
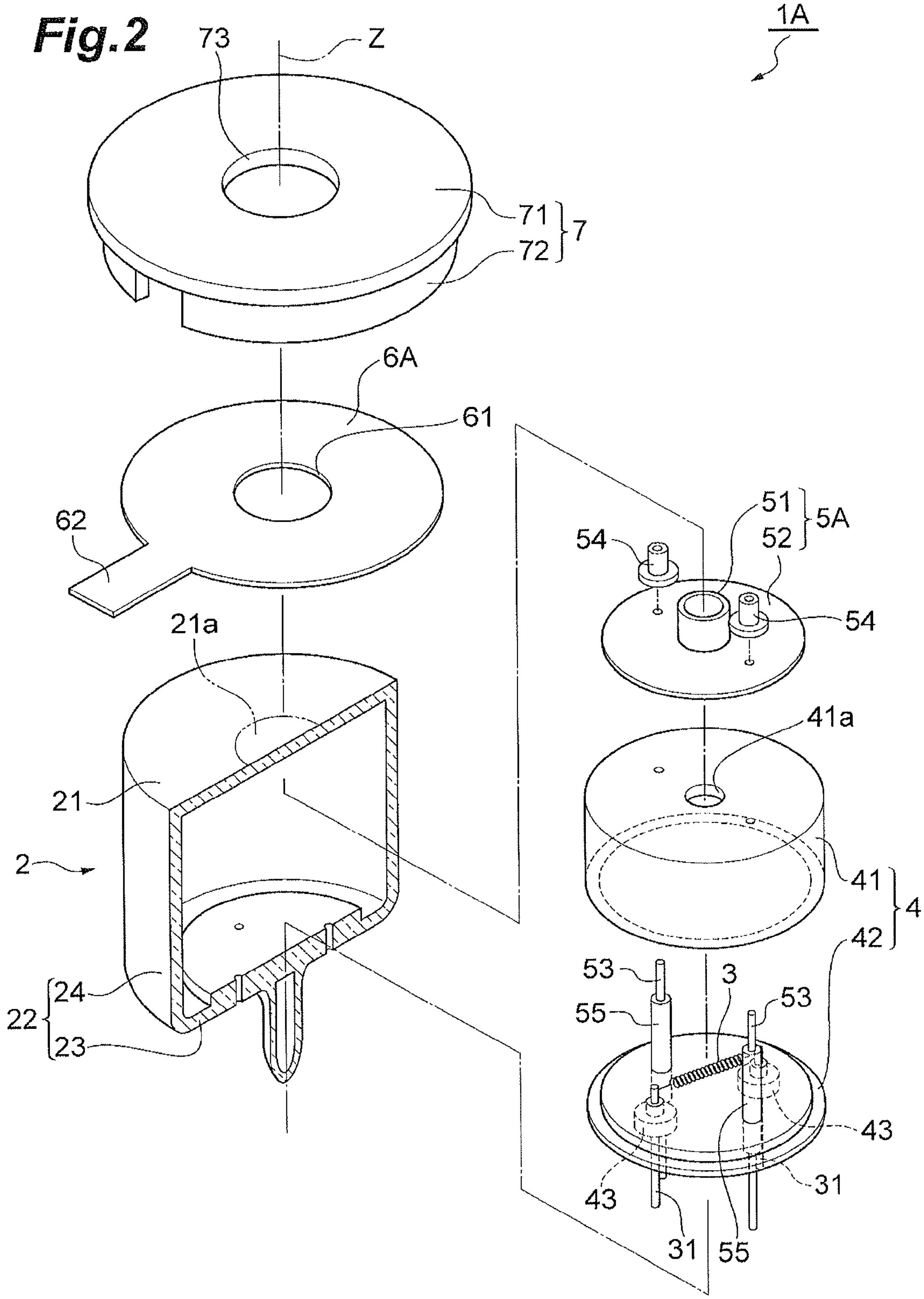
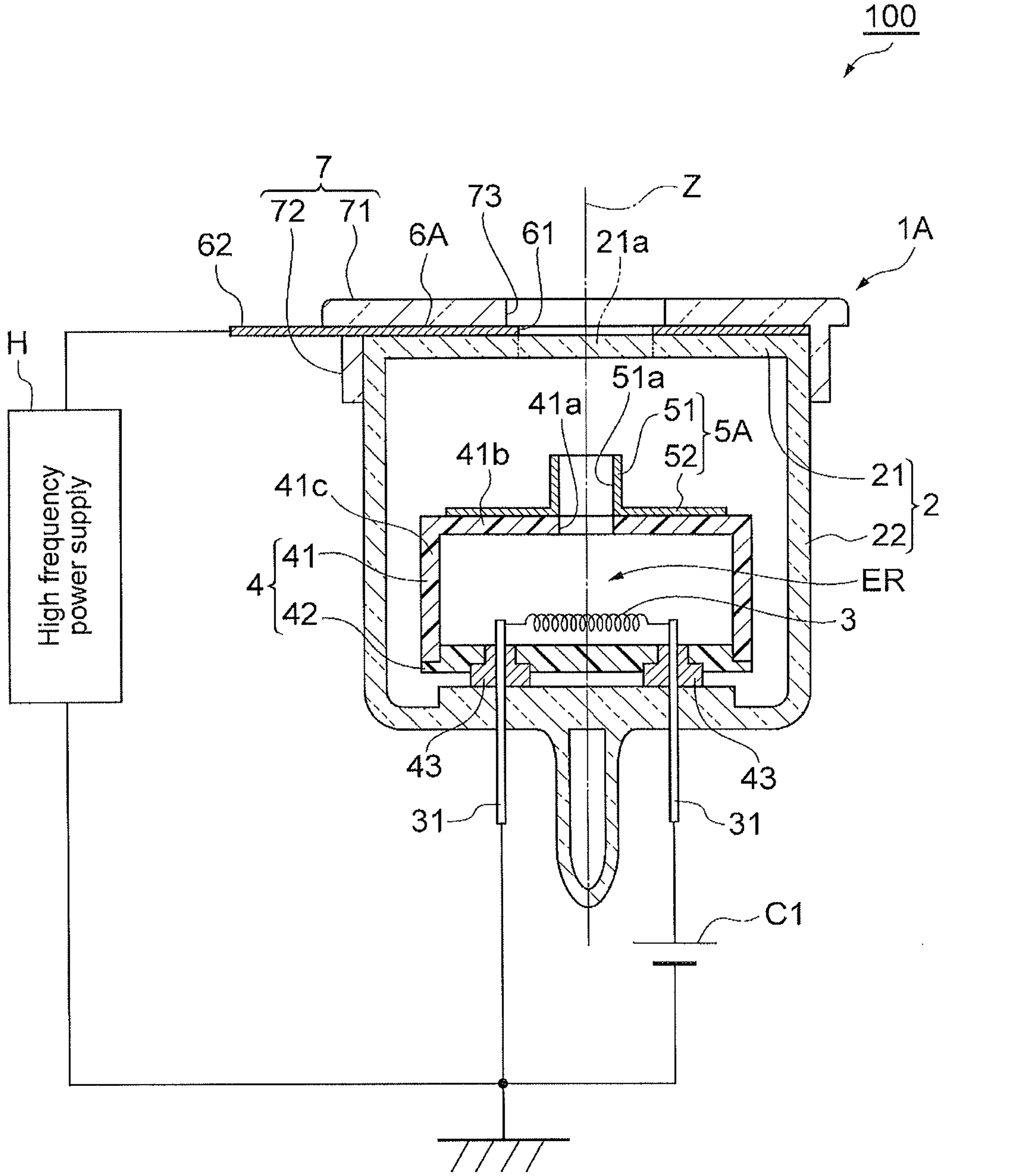


Fig.2



73
Z
1A
71
72
7
6A
61
62
51
52
5A
54
54
21a
41a
21
2
41
4
42
24
22
23
53
55
3
53
43
43
31
31
55

Fig.3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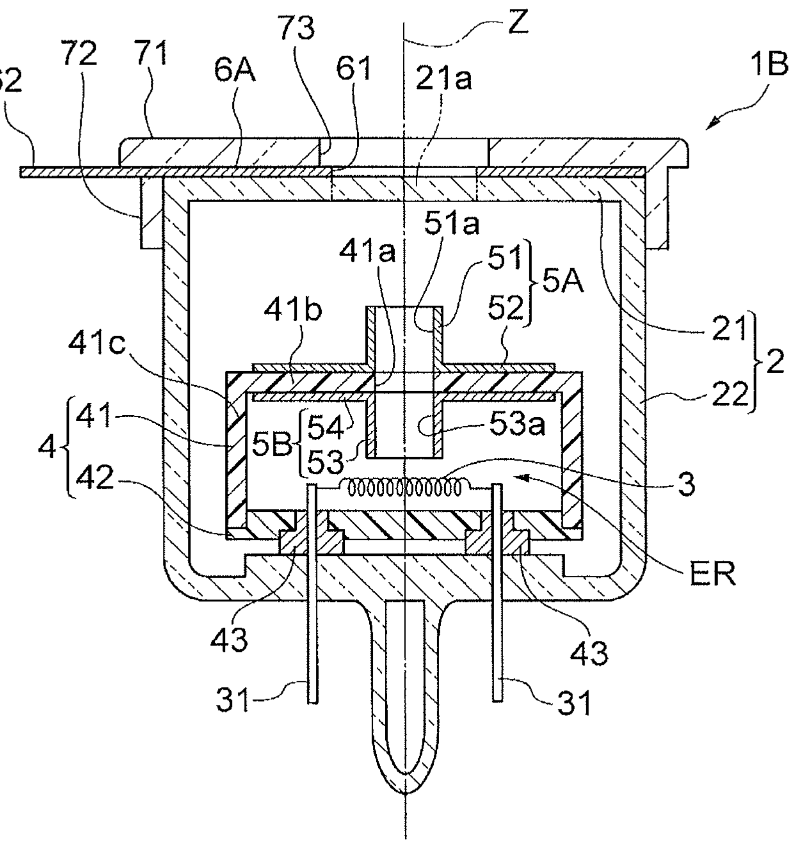
7
72
71
73
Z
62
6A
61
21a
1A
H
51a
41a
51
5A
41b
52
41c
21
2
22
High frequency power supply
4
41
ER
42
3
43
43
31
31
C1

Fig.4


Z
73
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6A
61
21a
1B
62
51a
41a
51
5A
52
41b
21
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41c
22
41
53a
4
5B
54
53
42
3
ER
43
43
31
31

Fig.5

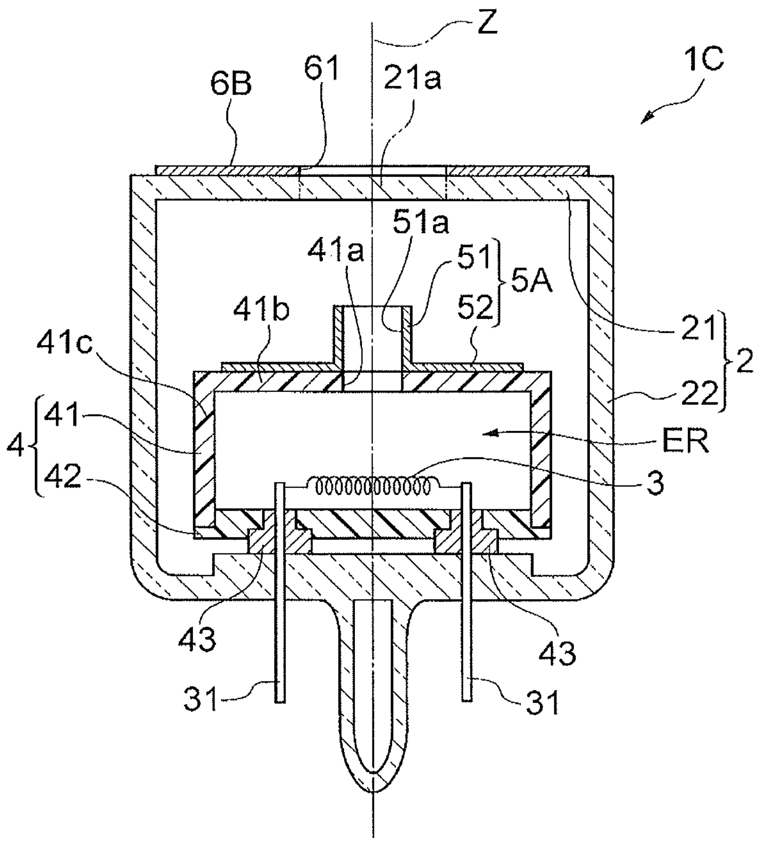
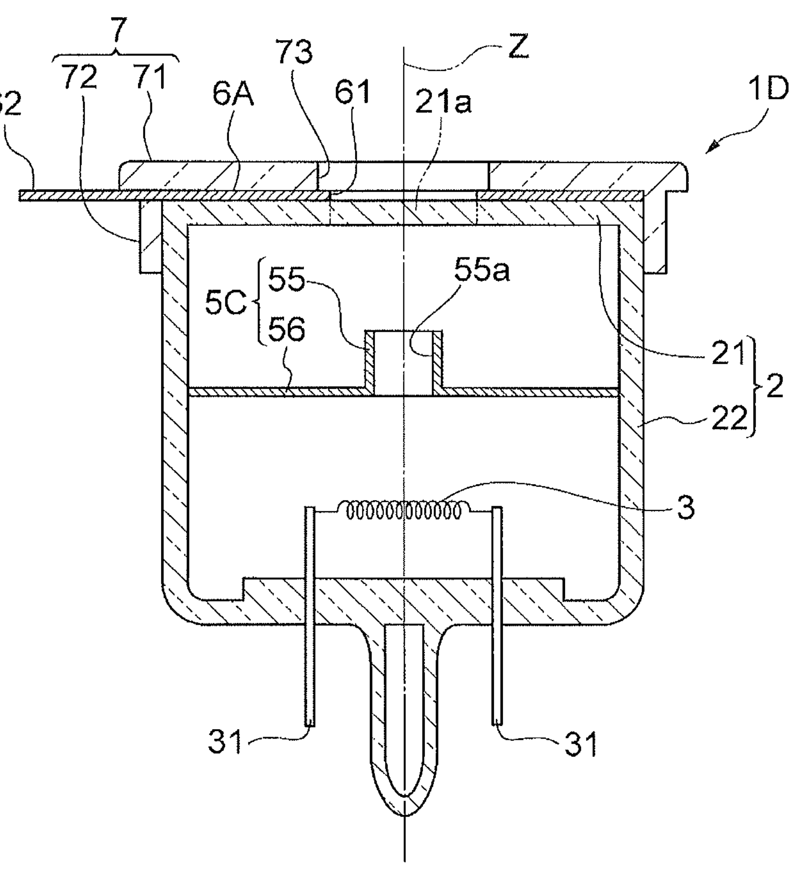


Fig.6



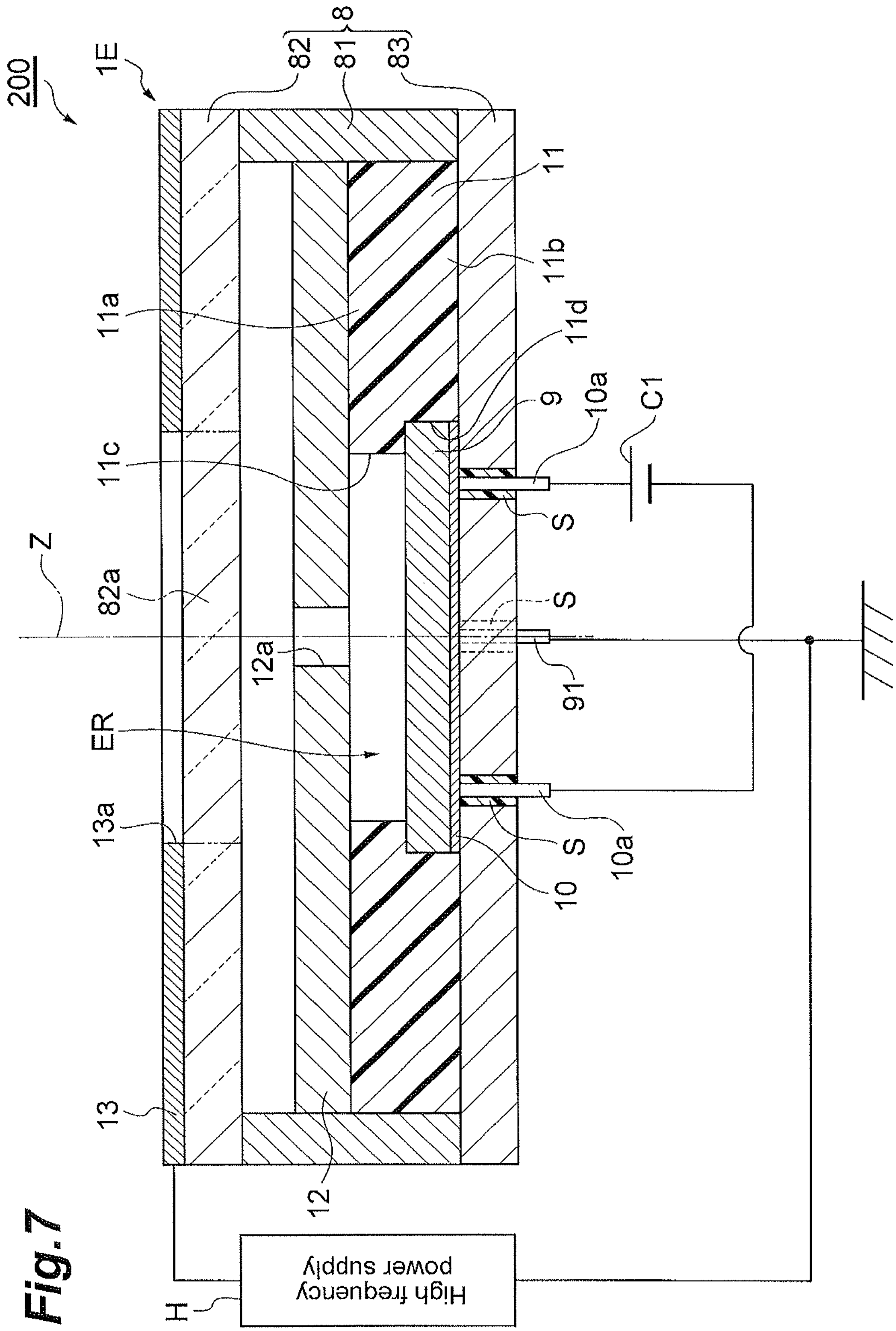

200
1E
8
82
81
83
11
11b
11a
11d
9
10a
C1
11c
S
Z
82a
S
12a
91
ER
13a
S
10a
10
13
12
H
High frequency power supply

Fig.7

DISCHARGE LAMP AND LIGHT SOURCE DEVICE

TECHNICAL FIELD

The present invention relates to a discharge lamp and a light source device including the discharge lamp.

BACKGROUND ART

Conventionally, a discharge lamp in which discharge emission occurs in a discharge gas such as heavy hydrogen and light is emitted is known (for example, see Patent Literatures 1 to 4). For example, an electrodeless discharge lamp including a discharge container of which an internal space is filled with heavy hydrogen, a pair of electrodes attached to an outer surface of the discharge container to face each other across the internal space, and a diaphragm member that limits a portion through which electrons pass in the internal space is described in Patent Literature 1. An opening through which light passes is provided in the electrode that is an anode. In this electrodeless discharge lamp, induction discharge occurs in the internal space when a high-frequency current is supplied between the pair of electrodes. When the discharge converges in the diaphragm body, point-shaped light is generated and emitted from the opening of the anode.

CITATION LIST

Patent Literature

[Patent Literature 1]
Japanese Patent No. 3385170
[Patent Literature 2]
Japanese Unexamined Patent Application Publication (Translation of PCT Application) No. 2005-519437
[Patent Literature 3]
Japanese Patent Laid-Open Publication No. Hei 2-273452
[Patent Literature 4]
Japanese Patent Laid-Open Publication No. Hei 6-60852

SUMMARY OF INVENTION

Technical Problem

In the above-described electrodeless discharge lamp, since electron flow occurs in the discharge gas only through the induction discharge, an amount of electrons supplied to the internal space is not sufficient in comparison with supply power. Therefore, in some cases, sufficient current density is not obtained. If the sufficient current density is not obtained, a sufficient amount of light may not be obtained. Meanwhile, when the supply power is increased so as to obtain sufficient current density, problems related to a withstand voltage such as occurrence of creeping discharge between the electrodes may occur because the pair of electrodes are both attached to the outer surface of the discharge container. Therefore, it may be difficult to perform a stable operation.

An object of the present invention is to provide a discharge lamp and a light source device in which sufficient current density and high stability can be achieved.

Solution to Problem

A discharge lamp according to an aspect of the present invention includes a housing including a dielectric portion having a light transmission area formed of a dielectric mate-

rial and transmitting light, and a main body portion forming a discharge-gas-filled space together with the dielectric portion, the discharge-gas-filled space being filled with a discharge gas; an electron emission source disposed in the discharge-gas-filled space to face the light transmission area; a discharge path limiting member separating the electron emission source and the light transmission area, in the discharge-gas-filled space, and including an electron passage hole that transmits electrons emitted from the electron emission source; and an external electrode disposed at an outer side of the housing to face the electron emission source across the dielectric portion, and including an opening that passes the light transmitted through the light transmission area.

A light source device according to an aspect of the present invention includes the above-described discharge lamp; and an AC power supply that supplies an AC current between the electron emission source and the external electrode.

In the discharge lamp and the light source device, since the electron emission source is disposed in the discharge-gas-filled space in the inner side of the housing, dielectric polarization occurs in the dielectric portion and discharge starts when an AC current is supplied between the electron emission source and the external electrode disposed at the outer side of the housing. Since a sufficient amount of electrons are emitted in the discharge gas from the electron emission source disposed in the discharge-gas-filled space, it is possible to obtain sufficient current density. Further, since a pair of electrodes are separately disposed in the inside and the outside of the housing, withstand voltage performance between the electrodes becomes high. Therefore, it is possible to perform a stable operation in which abnormal discharge does not occur.

The external electrode may be in contact with the dielectric portion. In this case, since dielectric polarization suitably occurs, a stable discharge state is maintained. Therefore, it is possible to perform a more stable operation.

The electron emission source may include a base that conducts an electric current; and an electron emitting portion provided on an outer surface of the base, and the electron emitting portion may be formed of an easily electron-emitting substance that emits electrons more easily than does a material forming the base. In this case, since electrons are emitted from the electron emitting portion formed of the easily electron-emitting substance, the electrons are more reliably emitted than when the electrons are emitted from the base. Therefore, it is possible to obtain more sufficient current density.

The discharge path limiting member may include a body portion and a lid portion provided around an electron emission source accommodation space that accommodates the electron emission source, the body portion may assume a wall shape surrounding the electron emission source when viewed from a direction in which the electron emission source and the light transmission area face one another, and the lid portion may be connected to an end portion on the light transmission area side of the body portion, and include the electron passage hole. In this case, the electrons emitted from the electron emitting portion are prevented from being incident on, for example, the main body portion of the housing. Therefore, it is possible to perform a more stable operation.

A protection member formed of a material having a higher melting point than a material forming the discharge path limiting member and including a through-hole may be included, and the protection member may be attached to the discharge path limiting member so that the through-hole and the electron passage hole communicate. In this case, a peripheral edge portion of the electron passage hole and the vicinity thereof that easily deteriorate due to discharge in the discharge path limiting member can be further protected by the protection member, and the discharge path is kept in a stable state. Therefore, it is possible to perform a more stable operation.

The discharge lamp may include a tubular portion connected to the discharge path limiting member, the inside of the tubular portion communicating with the electron passage hole, and the tubular portion may project toward the light transmission area or the electron emission source. In this case, higher current density can be obtained in the tubular portion.

The discharge lamp may include a cover fixed to the housing to cover the dielectric portion, and the external electrode may be interposed between the cover and the dielectric portion. In this case, the external electrode and the dielectric portion can be in close contact with each other, and a stable discharge state is maintained. Therefore, it is possible to perform a more stable operation.

The electron emission source may be a thermionic emission source that emits thermal electrons. In this case, since electrons can be suitably supplied, it is possible to perform a more stable operation.

A light source device may include the above-described discharge lamp; an AC power supply that supplies an AC current between the electron emission source and the external electrode; and a heating DC power supply that heats the electron emission source. In this case, since the electrons can be suitably supplied from the heated electron emission source, it is possible to perform a more stable operation.

Advantageous Effects of Invention

According to the present invention, it is possible to provide the discharge lamp and the light source device in which sufficient current density and high stability can be achieved.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a perspective view illustrating a discharge lamp of a first embodiment.

FIG. **2** is a partially cutaway exploded perspective view illustrating the discharge lamp of FIG. **1**.

FIG. **3** is a schematic configuration diagram illustrating an example of a photoelectric device including the discharge lamp of FIG. **1**.

FIG. **4** is a cross-sectional view illustrating a discharge lamp of a second embodiment.

FIG. **5** is a cross-sectional view illustrating a discharge lamp of a third embodiment.

FIG. **6** is a cross-sectional view illustrating a discharge lamp of a fourth embodiment.

FIG. **7** is a schematic configuration diagram illustrating an example of a light source device including a discharge lamp of a fifth embodiment.

DESCRIPTION OF EMBODIMENTS

Hereinafter, embodiments will be described in detail with reference to the drawings. Further, the same or corresponding elements are denoted with the same signs and a repeated description is omitted.

First Embodiment

FIG. **1** is a perspective view illustrating a discharge lamp of a first embodiment, and FIG. **2** is a partially cutaway exploded perspective view illustrating the discharge lamp of FIG. **1**. A discharge lamp **1**A illustrated in FIGS. **1** and **2** is a light source that causes discharge emission in a discharge gas and emits light. The discharge lamp **1**A includes a housing **2**, an internal electrode **3**, an electrode box **4**, an aperture **5**A, an external electrode **6**A, and a cover **7**.

The housing **2** is a container that contains the discharge gas. The inside of the housing **2** is a discharge-gas-filled space in which the discharge gas is filled. The discharge gas filled in the housing **2** is, for example, heavy hydrogen or xenon. Pressure (gas pressure) inside the housing **2** is, for example, about 100 to 10000 Pa. The housing **2** includes a tubular barrel portion **24**, and a pair of circular plate-shaped lid portions that close both ends of the barrel portion **24**. One of the lid portions constitutes a dielectric portion **21**, and the other lid portion constitutes a stem portion **23** that holds power supply pins **31** (to be described below), and fixing pins **53** (to be described below). The barrel portion **24** and the stem portion **23** constitute a main body portion **22**.

The dielectric portion **21** causes dielectric polarization and transmits the light generated inside the housing **2** to the outside. The dielectric portion **21** is formed of a dielectric material having a light transmission characteristic with respect to the light generated inside the housing **2**. For example, the dielectric portion **21** is formed of any glass or ceramic. The dielectric portion **21** is a plate-shaped member, and assumes, for example, a circular plate shape. A predetermined area, including a substantially central portion, in the dielectric portion **21**, that is, a circumferentially central area in the case of the circular plate-shaped dielectric portion **21**, is a light transmission area **21***a* that is a light emission window through which the light generated in the discharge-gas-filled space is transmitted.

The main body portion **22** forms the discharge-gas-filled space together with the dielectric portion **21**. The main body portion **22** is formed of an insulating material to which the dielectric portion **21** can be attached and, for example, is formed of any glass or ceramic. The main body portion **22** is integrally formed with the dielectric portion **21** to form a sealed space.

The internal electrode **3** is a thermionic emission source that emits thermal electrons to the discharge-gas-filled space, and functions as a hot cathode when the discharge occurs. The internal electrode **3** is disposed to face the light transmission area **21***a* in a position near the stem portion **23** in the discharge-gas-filled space.

For example, a filament is used as the internal electrode **3**. The internal electrode **3** includes a base that conducts electric current, and an electron emitting portion provided in an outer peripheral surface of the base. The base extends in a spring shape. The base is formed of, for example, tungsten. The electron emitting portion is formed of an easily electron-emitting substance that emits electrons more easily than does a material forming the base. For example, barium oxide is used as the easily electron-emitting substance. The electron emitting portion is formed, for example, by applying the easily electron-emitting substance to the base. One ends of the power supply pins **31** and **31** are connected to both end portions of the internal electrode **3**. Each of the two power supply pins **31** and **31** formed of a conductive member holds the internal electrode **3** in a predetermined spatial position inside the housing **2** at its one end. The other ends of the power supply pins **31** and **31** pass through a bottom lid **42** (to be described below) of the electrode box **4** and the stem portion **23** and project toward the outside of the housing **2**. The power supply pins **31** and **31** are erected and fixed to the stem portion **23**. The two power supply pins **31** and **31** are electrically connected to a high frequency power supply H (to be described below) and a constant voltage power supply C**1** (to be described below), respectively.

The electrode box **4** functions as a discharge path limiting member that limits a discharge path of the electrons emitted from the internal electrode **3**, and is provided around an electron emission source accommodation space ER that accommodates the internal electrode **3**. The electrode box **4** includes a surrounding portion **41**, and the bottom lid **42**. The surrounding portion **41** includes a cylindrical body portion **41***c* including a sidewall extending in an optical axis direction (to be described below), and a circular plate-shaped lid portion **41***b* extending in directions along the light transmission area **21***a*. The body portion **41***c* surrounds the internal electrode **3** when viewed from the optical axis direction. The lid portion **41***b* is connected to an end portion of the body portion **41***c* on the light transmission area **21***a* side. In this embodiment, the lid portion **41***b* and the body portion **41***c* are integrally formed. The lid portion **41***b* is disposed between the internal electrode **3** and the light transmission area **21***a*. The bottom lid **42** assumes a circular plate shape and is interpolated into the other end portion of the body portion **41***c* of the surrounding portion **41**.

The surrounding portion **41** and the bottom lid **42** are disposed coaxially with the housing **2** to surround the internal electrode **3**. The surrounding portion **41** and the bottom lid **42** separate the internal electrode **3** and the light transmission area **21***a*, in the discharge-gas-filled space, and are provided around the electron emission source accommodation space ER. A substantially circular electron passage hole **41***a* that causes the electrons emitted from the internal electrode **3** to pass is provided in a predetermined area, including a substantially central portion of the lid portion **41***b*, that is, a circumferentially central portion when the lid portion **41***b* has the circular plate shape. Further, a virtual line passing through the light transmission area **21***a* and the substantially central portion of the electron passage hole **41***a* is an optical axis Z, and an extending direction of the optical axis Z is an optical axis direction. In other words, the optical axis direction is a direction in which the light transmission area **21***a* and the electron emission source **3** face one another. A size (diameter) of the electron passage hole **41***a* in a direction intersecting the optical axis Z is smaller than a size (diameter) of the light transmission area **21***a* in the same direction, and smaller than a size (length) of the internal electrode **3** in a longitudinal direction (extending direction) in the same direction.

Spacers **43** and **43** are interposed between the bottom lid **42** and the main body portion **22** (see FIG. **3**). The spacer **43** assumes a cylindrical shape such that a section along the axis direction of the spacer **43** assumes a substantially 凸 shape. The spacer **43** is slipped over the power supply pin **31** and interposed between the power supply pin **31** and a through hole of the bottom lid **42**. The surrounding portion **41**, the bottom lid **42** and the spacer **43** are formed of, for example, an insulating material such as a ceramic. Therefore, the surrounding portion **41**, the bottom lid **42**, and the spacer **43** can electrically and thermally block the electron emission source accommodation space ER from the space in the housing **2** around the electron emission source accommodation space ER, and contribute to a stable operation of the internal electrode **3**. Further, since the bottom lid **42** is provided, the electrons emitted from the internal electrode **3** can be suppressed from going around from an end portion on the stem portion **23** side of the surrounding portion **41** to the dielectric portion **21**. Therefore, the electrons are easily concentrated on the aperture **5**A.

The aperture **5**A functions as a discharge path narrowing member that further extends a narrowed area of the discharge path limited by the electron passage hole **41***a*. Further, the aperture **5**A functions as a protection member that protects a peripheral edge portion of the electron passage hole **41***a* and the vicinity thereof. The aperture **5**A includes a cylindrical portion (tubular portion) **51** having a cylindrical shape, and a flange portion **52** having an annular shape projecting radially outward from one end portion of the cylindrical portion **51**. Both ends of the cylindrical portion **51** open, and a narrowing hole **51***a* penetrates into the cylindrical portion. An inner diameter of the narrowing hole **51***a* is substantially the same as that of the electron passage hole **41***a*, and a size (diameter) of the narrowing hole **51***a* in a direction intersecting the optical axis Z is smaller than a size (diameter) of the light transmission area **21***a* in the same direction and smaller than a size (length) of the internal electrode **3** in a longitudinal direction (extending direction) in the same direction. The cylindrical portion **51** is disposed to communicate with the electron passage hole **41***a* with being aligned on the same axis. That is, the cylindrical portion **51** is disposed on the optical axis Z. The flange portion **52** is in contact with a surface on the light transmission area **21***a* side of the lid portion **41***b*.

The two fixing pins **53** and **53** in a shaft shape pass through the flange portion **52**, the lid portion **41***b*, the bottom lid **42**, and the stem portion **23**. The fixing pin **53** formed of a conductive member is fixed to the stem portion **23**. A cylindrical fastener **54** of which a section along the axis direction assumes substantially a 凸 shape is slipped over the one end of the fixing pin **53**. The other end of the fixing pin **53** projects toward the outside of the housing **2**. The aperture **5**A is interposed between the lid portion **41***b* and the fastener **54**. A sleeve **55** formed of a cylindrical insulating material is slipped over the fixing pin **53** between the lid portion **41***b* and the stem portion **23**. The sleeve **55** is interposed between the fixing pin **53** and the bottom lid **42**. The aperture **5**A is formed of a material having a higher melting point than that of the material forming the electrode box **4**. For example, the aperture **5**A is formed of a high melting point metal such as molybdenum or tungsten, an alloy thereof, or a compound thereof. The fixing pin **53** is formed of, for example, a material having a thermal expansion coefficient close to that of a constituent material of the stem portion **23**, such as Kovar metal. The fastener **54** is formed of, for example, a metal such as nickel. The sleeve **55** is formed of, for example, a ceramic.

The aperture **5**A is fixed onto the lid portion **41** by caulking the fastener **54** to be fixed in a predetermined position of the fixing pin **53** and being pressed through the fastener **54** and the fixing pin **53** in a predetermined position on the lid portion **41***b*. Further, the surrounding portion **41** is fixed, as the entire electrode box **4**, to the stem portion **23** by fixing the fastener **54** and being pressed to the bottom lid **42**. Further, since the fixing pins **53** are covered with the sleeves **55**, the fixing pins **53** are not exposed to the electron emitting portion accommodation space ER. Therefore, failure such as discharge between the fixing pins **53** and the internal electrode **3** is suppressed. Further, the number of fixing pins **53** may be 1 or 3 or more as long as the aperture **5**A or the like is sufficiently fixed. Further, since the fixing pins **53** are at a floating potential and do not receive power supply, the fixing pins **53** are not limited to the conductive member and may be formed of an insulation material as long as the fixing pins **53** can reliably fix each component.

The external electrode **6**A functions as an anode when the discharge occurs. The external electrode **6**A is formed of a plate-shaped conductive member that assumes a substantially annular shape. An opening **61** is provided in a predetermined area, including a substantially central portion of the external electrode **6**A, that is, a circumferentially central portion when the external electrode **6**A has the substantially annular shape. A terminal **62** electrically connected to the high frequency power supply H (to be described below) extends radially outward from a predetermined place of an outer peripheral edge of the external electrode **6**A. The external electrode **6**A is formed of, for example, a metal such as nickel or aluminum.

The external electrode **6**A is disposed at the outer side of the housing **2** to face the internal electrode **3** across the dielectric portion **21**. Specifically, the external electrode **6**A is disposed coaxially with the housing **2**. The opening **61** is disposed on the optical axis Z and passes the light transmitted through the light transmission area **21***a*. That is, the internal electrode **3**, the electron passage hole **41***a*, the narrowing hole **51***a*, the light transmission area **21***a*, and the opening **61** are disposed coaxially on the optical axis Z. Further, substantially the entire surface on the dielectric portion **21** side of the external electrode **6**A except for the terminal **62** is in contact with the dielectric portion **21** in a planar shape.

The cover **7** is a member for fixing the external electrode **6**A to the dielectric portion **21**. The cover **7** includes an insulating member. The cover **7** includes an interposing portion **71** having an annular shape extending to face the dielectric portion **21**, and a slip-over portion **72** of a substantially cylindrical shape projecting in a direction along the barrel portion **24** from the vicinity of an outer peripheral edge of a surface on the dielectric portion **21** side of the interposing portion **71**. The slip-over portion **72** is slipped over the housing **2** so that the external electrode **6**A is interposed between the interposing portion **71** and the dielectric portion **21** and fixed to the housing **2** by an adhesive or the like in this state. Thus, the external electrode **6**A and the dielectric portion **21** are in close contact with each other. A notch for pulling out the terminal **62** of the external electrode **6**A is provided in the slip-over portion **72**. An opening **73** is provided in a predetermined area, including the substantially central portion of the interposing portion **71**, that is, a circumferentially central portion when the interposing portion **71** has the annular shape. The opening **73** is disposed on the optical axis Z, and causes light transmitted through the opening **61** of the external electrode **6**A to be emitted to the outside of the discharge lamp **1**A. That is, the internal electrode **3**, the electron passage hole **41***a*, the narrowing hole **51***a*, the light transmission area **21***a*, the opening **61**, and the opening **73** are coaxially disposed on the optical axis Z. The cover **7** is formed of, for example, a ceramic.

FIG. **3** is a schematic configuration diagram illustrating an example of a photoelectric device including the discharge lamp of FIG. **1**. A light source device **100** includes the discharge lamp **1**A, as illustrated in FIG. **3**. The light source device **100** is a device used for, for example, environmental measurement. The light source device **100** includes a high frequency power supply H and a constant voltage power supply C**1**, in addition to the discharge lamp **1**A.

The high frequency power supply H is an AC power supply that supplies an AC current between the internal electrode **3** and the external electrode **6**A, and is electrically connected to both the power supply pins **31** and **31** and the terminal **62** of the external electrode **6**A. A frequency of the AC current supplied from the high frequency power supply H is, for example, about 10 kHz to about 2.45 GHz. A peak voltage of the AC current supplied from the high frequency power supply H is, for example, several V to tens of kV. The constant voltage power supply C**1** is a heating DC power supply that heats the internal electrode **3**, and is electrically connected to both of the power supply pins **31** and **31**. The high frequency power supply H and the constant voltage power supply C**1** have a common ground path.

In the discharge lamp **1**A and the light source device **100** as described above, a DC current is supplied from the constant voltage power supply C**1** to the internal electrode **3**, and the internal electrode **3** is heated. In this state, the AC current from the high frequency power supply H is supplied between the internal electrode **3** disposed inside the discharge-gas-filled space of the housing **2** and the external electrode **6**A disposed outside the housing **2**. When the AC current is supplied, dielectric polarization occurs in the dielectric portion **21**. Thermal electrons emitted from the heated internal electrode **3** form discharge between the internal electrode **3** and the dielectric portion **21**. The discharge converges in the electron passage hole **41***a* and the narrowing hole **51***a* of the aperture **5**A, and point-shaped discharge emission occurs. Light generated due to the discharge emission passes through the light transmission area **21***a*, the opening **61** of the external electrode **6**A, and the opening **73** of the cover **7** and is emitted toward the outside of the discharge lamp **1**A. Thus, in the discharge lamp **1**A and the light source device **100**, since the electrons are emitted in the discharge gas from the internal electrode **3** disposed in the discharge-gas-filled space while the dielectric polarization occurs, sufficient current density is obtained. Further, since the internal electrode **3** and the external electrode **6**A connected to the high frequency power supply H are separately disposed inside and outside of the housing **2**, withstand voltage performance between the discharge electrodes is high. Therefore, it is possible to perform a stable operation in which failure such as creeping discharge does not occur. Further, the discharge lamp **1**A can be turned on within a relatively short period of time.

In the discharge lamp **1**A, the external electrode **6**A is in contact with the dielectric portion **21**. Therefore, the dielectric polarization suitably occurs, and a stable discharge state is maintained. Therefore, it is possible to perform a more stable operation.

In the discharge lamp **1**A, the internal electrode **3** includes the base that conducts an electric current, and the electron emitting portion provided on an outer surface of the base, and the electron emitting portion is formed of an easily electron-emitting substance such as barium oxide that emits electrons more easily than, for example, tungsten forming the base. Therefore, since the electrons are emitted from the electron emitting portion formed of the easily electron-emitting substance, the electrons are more reliably emitted than when electrons are emitted from the base. Therefore, it is possible to obtain more sufficient current density.

In the discharge lamp **1**A, the electrode box **4** includes the body portion **41***c* and the lid portion **41***b* provided around the electron emission source accommodation space ER that accommodates the internal electrode **3**. The body portion **41***c* assumes a wall shape surrounding the internal electrode **3** when viewed from a direction in which the internal electrode **3** and the light transmission area **21***a* face one another, the lid portion **41***b* is connected to an end portion on the light transmission area **21***a* side of the body portion **41***c*, and the electron passage hole **41***a* is provided in the lid portion **41***b*. Therefore, it is possible to prevent the electrons emitted from the internal electrode **3** from being incident on the main body portion **22** and the like. Therefore, it is possible to perform a more stable operation. In this embodiment, the body portion **41***c* assumes a cylindrical shape.

The discharge lamp **1**A includes the aperture **5**A formed of, for example, a high melting point metal, an alloy thereof, or a compound thereof having a higher melting point than that of, for example, the ceramic forming the electrode box **4**, and the narrowing hole **51***a* is provided in the aperture **5**A. The aperture **5**A is attached to a surface on the light transmission area **21***a* side of the lid portion **41***b* of the electrode box **4** so that the narrowing hole **51***a* and the electron passage hole **41***a* communicate. Therefore, a peripheral edge portion of the electron passage hole **41***a* and the vicinity thereof that easily deteriorate due to the discharge in the electrode box **4** can be protected by the aperture **5**A. Therefore, the discharge path can be kept in a stable state and a more stable operation can be performed.

In the discharge lamp **1**A, the cylindrical portion **51** that is attached to the electrode box **4** and of which the inside communicates with the electron passage hole **41***a* is provided, and the cylindrical portion **51** projects toward the light transmission area **21***a*. Therefore, a higher current density can be obtained in the cylindrical portion **51**.

In the discharge lamp **1**A, the electrons emitted from the internal electrode **3** converge in the electron passage hole **41***a* and the narrowing hole **51***a* of the aperture **5**A, and discharge emission occurs. Thus, the electron discharge path is narrowed by the aperture **5**A, and thus high luminance can be achieved.

The discharge lamp **1**A includes the cover **7** fixed to the housing **2** to cover the dielectric portion **21**, and the external electrode **6**A is sandwiched between the cover **7** and the dielectric portion **21**. Accordingly, the external electrode **6**A and the dielectric portion **21** are in close contact with each other, and a stable discharge state is maintained. Therefore, it is possible to perform a more stable operation.

In the discharge lamp **1**A, the internal electrode **3** is a thermionic emission source that emits thermal electrons. Therefore, electrons can be suitably supplied, and thus it is possible to perform a more stable operation.

The light source device **100** includes the discharge lamp **1**A, the high frequency power supply H that supplies the AC current between the internal electrode **3** and the external electrode **6**A, and the constant voltage power supply C**1** that heats the internal electrode **3**. Therefore, since the thermal electrons are emitted from the heated internal electrode **3**, the electrons can be stably supplied. Therefore, it is possible to perform a more stable operation.

Second Embodiment

FIG. **4** is a cross-sectional view illustrating a discharge lamp of a second embodiment. The discharge lamp **1**B of this embodiment and the discharge lamp **1**A of the first embodiment are different in that an aperture **5**B is attached to an inner side of an electrode box **4**.

The aperture **5**B has the same structure as the aperture **5**A of the first embodiment, and includes a cylindrical portion (tubular portion) **53** and a flange portion **54**. The aperture **5**B functions as a protection member that protects a peripheral edge portion of the electron passage hole **41***a* and the vicinity thereof, in addition to functioning as a discharge path narrowing member. A narrowing hole **53***a* of the cylindrical portion **53** is aligned coaxially with the electron passage hole **41***a*, that is, disposed on an optical axis Z. The flange portion **52** of the aperture **5**B is in contact with a surface on the internal electrode **3** side of the lid portion **41***b*. That is, the aperture **5**B is attached to the surface on the internal electrode **3** side of the lid portion **41***b* so that the narrowing hole **53***a* of the cylindrical portion **53** and the electron passage hole **41***a* communicate. For example, the attachment of the flange portion **52** of the aperture **5**B to the surrounding portion **41** can be realized by being interposed between the sleeve **55** slipped over the fixing pin **53** and the surface on the internal electrode **3** side of the lid portion **41***b* and caulking the fastener **54**, as in the attachment of the flange portion **52** of the aperture **5**A to the surrounding portion **41**.

In the discharge lamp **1**B as described above, a DC current is supplied to the internal electrode **3**, and the internal electrode **3** is heated. In this state, when an AC current is supplied between the internal electrode **3** and the external electrode **6**A, dielectric polarization occurs in the dielectric portion **21**. Electrons are emitted in the discharge gas from the internal electrode **3**, and discharge is formed between the internal electrode **3** and the dielectric portion **21**. The discharge converges in the narrowing hole **53***a* of the aperture **5**B, the electron passage hole **41***a*, and the narrowing hole **51***a* of the aperture **5**A, and point-shaped discharge emission occurs. Light generated due to the discharge emission passes through the light transmission area **21***a*, an opening **61** of the external electrode **6**A and an opening **73** of the cover **7**, and is emitted to the outside of the discharge lamp **1**B.

Such a discharge lamp **1**B has the same effects as the discharge lamp **1**A of the first embodiment. Further, the discharge lamp **1**B includes the aperture **5**B formed of, for example, a high melting point metal, an alloy thereof, or a compound thereof having a higher melting point than that of, for example, the ceramic forming the electrode box **4**, and the narrowing hole **53***a* is provided. The aperture **5**B is attached to the surface on the internal electrode **3** side of the lid portion **41***b* of the electrode box **4** so that the narrowing hole **53***a* and the electron passage hole **41***a* communicate. Therefore, the peripheral edge portion of the electron passage hole **41***a* and the vicinity thereof that easily deteriorate due to the discharge in the electrode box **4** can be further protected by the aperture **5**B, and the discharge path is kept in a stable state. Therefore, it is possible to perform a more stable operation.

In the discharge lamp **1**B, the cylindrical portion **53** that is attached to the electrode box **4** and of which the inside communicates with the electron passage hole **41***a* is provided, and the cylindrical portion **53** projects toward the internal electrode **3**. Therefore, it is possible to further increase current density in the cylindrical portion **53**.

Further, in the discharge lamp **1**B, the electrons emitted from the internal electrode **3** converge in the narrowing hole **53***a* of the aperture **5**B, the electron passage hole **41***a*, and the narrowing hole **51***a* of the aperture **5**A, and the discharge emission occurs. Thus, since the discharge path of electrons is narrowed by both the aperture **5**A and the aperture **5**B, higher luminance can be achieved.

Third Embodiment

FIG. **5** is a cross-sectional view illustrating a discharge lamp of a third embodiment. A discharge lamp **1**C of this embodiment and the discharge lamp **1**A of the first embodiment are different in that an external electrode **6**B is fixed to a dielectric portion **21** without using a cover.

The external electrode **6**B assumes an annular shape. The external electrode **6**B is formed by depositing, for example, a metal such as nickel or aluminum on an outer surface of the dielectric portion **21**, and is formed of a conductive film. The external electrode **6**B is disposed coaxially with a housing **2**, as in the external electrode **6**A.

In the discharge lamp **1**C as described above, a DC current is supplied to the internal electrode **3**, and the internal electrode **3** is heated. In this state, when an AC current is supplied between the internal electrode **3** and the external electrode **6**B, dielectric polarization occurs in the dielectric portion **21**. Electrons are emitted in a discharge gas from the internal electrode **3**, and discharge is formed between the internal electrode **3** and the dielectric portion **21**. The discharge converges in the electron passage hole **41***a* and a narrowing hole **51***a*, and point-shaped discharge emission occurs. Light generated due to the discharge emission passes through the light transmission area **21***a* and an opening **61** of the external electrode **6**B and is emitted to the outside of the discharge lamp **1**C.

Such a discharge lamp **1**C has the same effects as the discharge lamp **1**A of the first embodiment. Further, in the discharge lamp **1**C, it is possible to achieve improvement of close contact with the dielectric portion **21**, reduction of number of parts, and miniaturization of the device since the external electrode **6**B is fixed to the dielectric portion **21** through deposition or the like without using the cover.

Fourth Embodiment

FIG. **6** is a cross-sectional view illustrating a discharge lamp of a fourth embodiment. A discharge lamp **1**D of this embodiment includes an aperture **5**C in addition to a housing **2**, an internal electrode **3**, an external electrode **6**A, and a cover **7**.

The aperture **5**C functions as a discharge path limiting member having an electron passage hole that limits a discharge path of electrons emitted from the internal electrode **3**. The aperture **5**C includes a cylindrical portion **55**, and a flange portion **56** that projects radially outward from one end portion of the cylindrical portion **55**. A through-hole **55***a* formed in the cylindrical portion **55** functions as an electron passage hole that passes the electrons emitted from the internal electrode **3** like the above-described electron passage hole **41***a*, and functions as a narrowing hole that narrows the discharge path like the above-described narrowing hole **51***a*. The aperture **5**C is disposed between the internal electrode **3** and a light transmission area **21***a* in the discharge-gas-filled space, and separates the internal electrode **3** and the light transmission area **21***a*. An outer diameter of the flange portion **56** is substantially the same as the inner diameter of a barrel portion **24**. An outer peripheral edge of the flange portion **56** is fixed to an inner peripheral surface of the barrel portion **24**, for example, using fusion bonding or an adhesive. The aperture **5**C is formed of, for example, a high melting point metal such as molybdenum or tungsten, an alloy thereof, or a compound thereof.

In the discharge lamp **1**D as described above, a DC current is supplied to the internal electrode **3**, and the internal electrode **3** is heated. In this state, when an AC current is supplied between the internal electrode **3** and the external electrode **6**A, dielectric polarization occurs in the dielectric portion **21**. Electrons are emitted in a discharge gas from the internal electrode **3**, and discharge is formed between the internal electrode **3** and the dielectric portion **21**. The discharge converges in the through-hole **55***a* of the aperture **5**C, and a point-shaped discharge emission occurs. Light generated due to the discharge emission passes through the light transmission area **21***a*, an opening **61** of the external electrode **6**A, and an opening **73** of the cover **7** and is emitted to the outside of the discharge lamp **1**D.

Such a discharge lamp **1**D has the same effects as the discharge lamp **1**A of the first embodiment. Further, in the discharge lamp **1**D, since the aperture **5**C functioning as the discharge path limiting member is directly fixed to the housing **2**, a part such as the electrode box **4** can be removed. Therefore, it is possible to achieve reduction of number of parts and reduction of a manufacturing cost.

Fifth Embodiment

FIG. **7** is a schematic configuration diagram illustrating an example of a light source device including a discharge lamp of a fifth embodiment. A discharge lamp **1**E of this embodiment has a flat shape in which an external form is a polygon or circle, and has a plate-shaped structure in which a length (thickness) in a light emission direction is smaller than a length (width) in a direction perpendicular to the emission direction. The discharge lamp **1**E includes a housing **8**, an internal electrode **9**, a heater **10**, an insulator **11**, an aperture **12**, and an external electrode **13**.

The housing **8** is a container that contains a discharge gas, and the inside of the housing **8** is a discharge-gas-filled space filled with the discharge gas. The housing **8** includes a tubular barrel portion **81**, a plate-shaped window material **82** that closes one end portion of the barrel portion **81**, and a plate-shaped stem portion **83** that closes the other end portion of the barrel portion **81**.

The window material **82** functions as a dielectric portion that generates dielectric polarization and transmits light generated inside the housing **8** to the outside. The window material **82** is formed of a dielectric material having a light transmission characteristic with respect to the light generated in the housing **8**, and for example, is formed of any glass or ceramic. The window material **82** is a plate-shaped member. A predetermined area including a substantially central portion in the dielectric portion **21** is a substantially circular light transmission area **82***a* that is a light emitting window that transmits the light generated in the discharge-gas-filled space.

The barrel portion **81** and the stem portion **83** function as a main body portion forming the discharge-gas-filled space together with the window material **82**. The barrel portion **81** and the stem portion **83** are formed of a conductive material such as a metal or an insulating material such as glass or a ceramic. For example, the barrel portion **81** may be formed of a metal such as indium, and the stem portion **83** may be formed of a metal, glass, or a ceramic.

The internal electrode **9** is a thermionic emission source that emits thermal electrons to the discharge-gas-filled space, and functions as a hot cathode when the discharge occurs. The internal electrode **9** is stacked on a surface on the discharge-gas-filled space side of the stem portion **83** via the heater **10**, in the discharge-gas-filled space, and faces the light transmission area **82***a*.

The internal electrode **9** assumes a flat plate shape extending in directions along the light transmission area **82***a*. The internal electrode **9** includes a base that is a plate-shaped member or a film-shaped member formed of a conductive member, and an electron emitting portion provided on an outer surface of the base facing the light transmission area **82***a*. The electron emitting portion is formed, for example, by applying an easily electron-emitting substance such as barium oxide to the base. One end of a cathode power supply pin **91** formed of a conductive member is connected to the internal electrode **9**. The other end portion of the cathode power supply pin **91** passes through the stem portion **83** and projects toward the outside of the housing **8**. The cathode power supply pin **91** is electrically connected to a high frequency power supply H. Further, when the stem portion **83** is formed of an insulating material, the cathode power supply pin **91** is directly held by the stem portion **83**. On the other hand, when the stem portion **83** is formed of a metal, a spacer

S (for example, a hermetic seal) formed of an insulating material is interposed between the cathode power supply pin **91** and the stem portion **83**.

The heater **10** is a heating source that heats the internal electrode **9**. The heater **10** assumes a flat shape to be able to be in close contact with the internal electrode **9**, and is interposed between the internal electrode **9** and the stem portion **83**. The heater **10** is formed, for example, by disposing linear members formed of a high melting point metal such as tungsten in a planar shape. One end of each of a pair of heater power supply pins **10***a* and **10***a* formed of a conductive member is connected to the heater **10**. The other end of each heater power supply pin **10***a* penetrates the stem portion **83** and projects to the outside of the housing **8**. The heater power supply pins **10***a* are connected to the constant voltage power supply C**1**. Further, when the stem portion **83** is formed of a metal, a spacer S is interposed between the heater power supply pin **31***a* and the stem portion **83**, as in the cathode power supply pin **91**.

The insulator **11** functions as a discharge path limiting member that electrically insulates between the housing **8** and the internal electrode **9** and limits the discharge path of the electrons emitted from the internal electrode **9**. The insulator **11** assumes a substantially tubular shape, and is inserted into the barrel portion **81** so that an outer surface of the insulator **11** is in contact with an inner surface of the barrel portion **81**. The insulator **11** is stacked on the stem portion **83**. The insulator **11** includes a lid portion **11***a* on the light transmission area **82***a* side, and a body portion **11***b* on the stem portion **83** side. The body portion **11***b* surrounds the internal electrode **9** when viewed from an optical axis direction (to be described below). The lid portion **11***a* is connected to an end portion on the light transmission area **82***a* side of the body portion **11***b*. An inner surface **11***c* of the lid portion **11***a* is smaller than an inner surface **11***d* of the body portion **11***b*, and a marginal region of the internal electrode **9** is interposed between a surface on the stem portion **83** side of the lid portion **11***a* and the stem portion **83**. Thus, an electron emission source accommodation space ER that accommodates the internal electrode **9** is provided by the lid portion **11***a* and the body portion **11***b*. The inner surface **11***c* of the lid portion **11***a* functions as an electron passage hole that passes the electrons emitted from the internal electrode **9**. The insulator **11** is formed of, for example, an insulating material such as glass or a ceramic.

The aperture **12** functions as a discharge path narrowing member that further narrows the discharge path limited by the inner surface **11***c* of the lid portion **11***a*, and functions as a protection member that protects the inner surface **11***c* of the lid portion **11***a* and the vicinity thereof. The aperture **12** assumes a substantially flat plate shape (face plate shape) extending in directions along the light transmission area **82***a*, and is inserted into the barrel portion **81** so that an outer surface thereof is in contact with an inner surface of the barrel portion **81**. The aperture **12** is stacked on a surface on the light transmission area **82***a* side of the insulator **11**. A narrowing hole **12***a* having a substantially circular shape that passes the electrons emitted from the internal electrode **9** is provided in a predetermined area, including a substantially central portion of the aperture **12**. The aperture **12** is disposed so that the inner surface **11***c* of the lid portion **11***a* and the narrowing hole **12***a* communicate. The aperture **12** is formed of, for example, a high melting point metal such as molybdenum or tungsten, an alloy thereof, or a compound thereof, and can protect the insulator **11** at the time of discharge. Further, the aperture **12** may be formed, for example, of the same material as the insulator **11** and integrally with the insulator **11**. In this case, for example, a protection member formed of a high melting point metal such as molybdenum or tungsten, an alloy thereof, or a compound thereof on the surface on the light transmission area **82***a* side of the aperture **12** may be further disposed. Further, a virtual line passing through a substantially central portion of the light transmission area **82***a* and the narrowing hole **12***a* is an optical axis Z, and an extending direction of the optical axis Z is an optical axis direction. In other words, the optical axis direction is a direction in which the internal electrode **9** and the light transmission area **82***a* face one another. A size (diameter) of the narrowing hole **12***a* in a direction intersecting the optical axis Z is smaller than a size (diameter) of the light transmission area **82***a* in the same direction, a size (diameter) of the inner surface **11***c* in the same direction, and a size (length) of the internal electrode **9** in the same direction.

The external electrode **13** functions as an anode when the discharge occurs. The external electrode **13** is a flat plate-shaped conductive member formed by depositing, for example, a metal such as nickel or aluminum on the outer surface of the window material **82**. The external electrode **13** is disposed at the outer side of the housing **8** to face the internal electrode **9** across the window material **82**. A circular opening **13***a* formed in a predetermined area, including a substantially central portion of the external electrode **13**, is disposed on the optical axis Z and passes the light transmitted through light transmission area **82***a*. That is, the internal electrode **9**, the opening **11***a*, the narrowing hole **12***a*, the light transmission area **82***a*, and the opening **13***a* are coaxially disposed on the optical axis Z.

The light source device **200** including the discharge lamp **1**E includes a high frequency power supply H and a constant voltage power supply C**1** as described above. The high frequency power supply H is grounded. The constant voltage power supply C**1** supplies an electric current to the heater **10**, and the internal electrode **9** is heated using the heater **10**.

In the discharge lamp **1**E and the light source device **200** as described above, a DC current is supplied from the constant voltage power supply C**1** to the heater **10**, and the internal electrode **9** is heated using the heater **10**. In this state, an AC current from the high frequency power supply H is supplied between the internal electrode **9** disposed in the discharge-gas-filled space on the inner side of the housing **8** and the external electrode **13** disposed at the outer side of the housing **8**. When the AC current is supplied, dielectric polarization occurs in the window material **82**. Thermal electrons emitted from the heated internal electrode **9** form discharge between the internal electrode **9** and the window material **82**. The discharge converges in the narrowing hole **12***a*, and point-shaped discharge emission occurs. Light generated due to the discharge emission passes through the light transmission area **82***a* and the opening **13***a* of the external electrode **13** and is emitted to the outside of the discharge lamp **1**E. Thus, in the discharge lamp **1**E and the light source device **200**, since the electrons are emitted in the discharge gas from the internal electrode **9** disposed in the discharge-gas-filled space while the dielectric polarization occurs, sufficient current density is obtained. Further, since the internal electrode **9** and the external electrode **13** connected to the high frequency power supply H are separately disposed inside and outside of the housing **8**, withstand voltage performance between the discharge electrodes becomes high. Therefore, it is possible to perform a stable operation in which failure such as creeping discharge does not occur. Further, the discharge lamp **1**E can be turned on within a relatively short period of time. Further, in the discharge lamp **1**E, the internal electrode and the heater may be integrally configured to energize and heat the conductive material having an easily electron-emitting substance provided on an outer surface, as in the discharge lamp **1**A of the first embodiment.

The discharge lamp **1**E is configured by stacking main components such as the stem portion **83**, the barrel portion **81**, the heater **10**, the internal electrode **9**, the insulator **11**, the aperture **12**, the window material **82**, and the external electrode **13**. Therefore, the discharge lamp **1**E can be easily manufactured and can be downsized. Particularly, in the discharge lamp **1**E, a manufacturing method in which a plurality of discharge lamps **1**E are integrally formed using a substrate including a plurality of portions corresponding to the window materials **82**, and a substrate including a plurality of portions corresponding to the stem portions **83**, and are cut into the discharge lamps **1**E after the discharge gas is filled can be adopted.

In the discharge lamp **1**E, the external electrode **13** is in contact with the window material **82**. Therefore, dielectric polarization suitably occurs, and thus a stable discharge state is maintained. Therefore, it is possible to perform a more stable operation. Further, in the discharge lamp **1**E, the external electrode **13** is fixed to the window material **82** through deposition without using a cover or the like, and thus it is possible to achieve improvement of close contact of the external electrode **13** with the window material **82**, reduction of number of parts, and miniaturization of the device.

In the discharge lamp **1**E, the internal electrode **9** includes a base that conducts an AC current, and an electron emitting portion provided on the outer surface of the base, and the electron emitting portion is formed of an easily electron-emitting substance such as barium oxide that emits electrons more easily than the tungsten or the like which forming the base. Accordingly, since the electrons are emitted from the electron emitting portion formed of the easily electron-emitting substance, the electrons are emitted more reliably than when electrons are emitted from the base. Therefore, it is possible to obtain more sufficient current density.

In the discharge lamp **1**E, the insulator **11** includes the body portion **11***b* and the lid portion **11***a* surrounding the electron emission source accommodation space ER that accommodates the internal electrode **9**, the body portion **11***b* assumes a wall shape surrounding the internal electrode **9** when viewed from a direction in which the internal electrode **9** and the light transmission area **82***a* face one another, the lid portion **11***a* is connected to the end portion on the light transmission area **82***a* side of the body portion **11***b*, and the inner surface **11***c* is provided as the electron passage hole. Therefore, the electrons emitted from the internal electrode **9** can be prevented from being incident on the barrel portion **81** and the like. Therefore, it is possible to perform a more stable operation.

The discharge lamp **1**E includes the aperture **12** that is formed of, for example, a high melting point metal, an alloy thereof, or a compound thereof having a higher melting point than the ceramic forming the lid portion **11***a* of the insulator **11**, and the narrowing hole **12***a* is provided in the aperture **12**. The aperture **12** is attached to the surface on the light transmission area **82***a* side of the lid portion **11***a* so that the narrowing hole **12***a* and the inner surface **11***c* of the lid portion **11***a* communicate. Therefore, the inner surface **11***c* of the lid portion **11***a* and the vicinity thereof that easily deteriorate due to the discharge in the insulator **11** can be protected by the aperture **12**. Therefore, the discharge path is kept in a stable state and a more stable operation can be performed.

In the discharge lamp **1**E, the internal electrode **9** is a thermionic emission source that emits thermal electrons. Therefore, the electrons can be suitably supplied, and thus it is possible to perform a more stable operation.

The light source device **200** includes the discharge lamp **1**E, the high frequency power supply H that supplies the AC current between the internal electrode **9** and the external electrode **13**, and the constant voltage power supply C**1** for heating the internal electrode **9** through the heater **10**. Further, the discharge lamp **1**E includes the heater **10** for heating the internal electrode **9**. Therefore, since the thermal electrons are suitably emitted from the heated internal electrode **9**, the electrons are emitted in a more stable manner. Therefore, it is possible to perform a more stable operation.

While the preferred embodiments of the discharge lamp and the light source device of the present invention have been described above, the present invention is not limited to the above-described embodiments. For example, in the discharge lamps **1**A to **1**D, while the dielectric portion **21** and the main body portion **22** are integrally formed of the same material, the dielectric portion **21** and the main body portion **22** may be formed of different materials.

While the internal electrodes **3** and **9** include the base formed of, for example, tungsten, and the electron emitting portion formed of the easily electron-emitting substance such as barium oxide, the electrons may be emitted through thermionic emission from the base without including the electron emitting portion. Further, instead of a directly heated type in which the internal electrode **3** itself is energized and heated by the constant voltage power supply C**1**, the internal electrode **3** may be an indirectly heated type in which the high frequency power supply H is connected to the internal electrode **3**, a heater disposed near the internal electrode **3** to heat the internal electrode **3** is provided, and the constant voltage power supply C**1** is connected to the heater, as in the internal electrode **9**. Further, while the internal electrodes **3** and **9** are hot cathodes, the internal electrodes **3** and **9** may be cold cathodes.

While the external electrodes **6**A and **6**B are in contact with only the dielectric portion **21** in the housing **2**, the external electrodes **6**A and **6**B may extend to cover the outer surface on the dielectric portion **21** side of the barrel portion **24** and come in contact with the barrel portion **24**. In this case, high luminance can be achieved due to increase in an amount of discharge.

INDUSTRIAL APPLICABILITY

According to the present invention, it is possible to provide the discharge lamp and the light source device in which sufficient current density and high stability can be achieved.

REFERENCE SIGNS LIST

1A to **1**E: Discharge lamp, **2**: Housing, **3**: Internal electrode, **4**: Electrode box, **5**A to **5**C: Aperture, **6**A and **6**B: External electrode, **7**: Cover, **8**: Housing, **9**: Internal electrode, **12**: Aperture, **12***a*: Electron passage hole, **13**: External electrode, **13***a*: Opening, **21**: Dielectric portion, **21***a*: Light transmission area, **22**: Main body portion, **41***a*: Electron passage hole, **61**: Opening, **81**: Barrel portion, **82**: Window material, **82***a*: Light transmission area, **83**: Stem portion, H: High frequency power supply, C**1**: Constant voltage power supply.

The invention claimed is:

1. A discharge lamp comprising:

a housing including a dielectric portion having a light transmission area formed of a dielectric material and transmitting light, and a main body portion forming a discharge-gas-filled space together with the dielectric portion, the discharge-gas-filled space being filled with a discharge gas;

an electron emission source disposed in the discharge-gas-filled space to face the light transmission area;

a discharge path limiting member separating the electron emission source and the light transmission area, in the discharge-gas-filled space, and including an electron passage hole that transmits electrons emitted from the electron emission source; and

an external electrode disposed at an outer side of the housing to face the electron emission source across the dielectric portion, and including an opening that passes the light transmitted through the light transmission area.

2. The discharge lamp according to claim **1**,

wherein the external electrode is in contact with the dielectric portion.

3. The discharge lamp according to claim **1**,

wherein the electron emission source includes

a base that conducts an electric current; and

an electron emitting portion provided on an outer surface of the base, and

the electron emitting portion is formed of an easily electron-emitting substance that emits electrons more easily than does a material forming the base.

4. The discharge lamp according to claim **1**,

wherein the discharge path limiting member includes a body portion and a lid portion provided around an electron emission source accommodation space that accommodates the electron emission source,

the body portion assumes a wall shape surrounding the electron emission source when viewed from a direction in which the electron emission source and the light transmission area face one another, and

the lid portion is connected to an end portion on the light transmission area side of the body portion, and includes the electron passage hole.

5. The discharge lamp according to claim **1**, further comprising:

a protection member formed of a material having a higher melting point than a material forming the discharge path limiting member and including a through-hole,

wherein the protection member is attached to the discharge path limiting member so that the through-hole and the electron passage hole communicate.

6. The discharge lamp according to claim **1**, further comprising:

a tubular portion connected to the discharge path limiting member, the inside of the tubular portion communicating with the electron passage hole,

wherein the tubular portion projects toward the light transmission area or the electron emission source.

7. The discharge lamp according to claim **1**, further comprising:

a cover fixed to the housing to cover the dielectric portion,

wherein the external electrode is interposed between the cover and the dielectric portion.

8. The discharge lamp according to claim **1**,

wherein the electron emission source is a thermionic emission source that emits thermal electrons.

9. A light source device comprising:

the discharge lamp according to claim **1**; and

an AC power supply that supplies an AC current between the electron emission source and the external electrode.

10. A light source device comprising:

the discharge lamp according to claim **8**;

an AC power supply that supplies an AC current between the electron emission source and the external electrode; and

a heating DC power supply that heats the electron emission source.

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